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P01/7700 0.00-0324800.2

Request for grant of a patent

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1. Your reference

2. Patent application number

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0324800.2

3. Full name, address and postcode of the or of each applicant (underline all surnames)

Trafficmaster Plc
University Way
Cranfield
Bedfordshire, MK43 0TR

Patents ADP number (if you know it)

8139073001

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention

Route Guidance System

5. Name of your agent (if you have one)

Murgitroyd & Company

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

Scotland House
165-169 Scotland Street
Glasgow G5 8PL
Scotland
United Kingdom

Patents ADP number (if you know it)

1198015 ✓

6. Priority: Complete this section if you are declaring priority from one or more earlier patent applications, filed in the last 12 months.

Country

Priority application number
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Date of filing
(day / month / year)

7. Divisionals, etc: Complete this section only if this application is a divisional application or resulted from an entitlement dispute (see note f)

Number of earlier UK application

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8. Is a Patents Form 7/77 (Statement of inventorship and of right to grant of a patent) required in support of this request?

Yes

Answer YES if:

- a) any applicant named in part 3 is not an inventor, or
- b) there is an inventor who is not named as an applicant, or
- c) any named applicant is a corporate body.

Otherwise answer NO (See note d)

9. Accompanying documents: A patent application must include a description of the invention. Not counting duplicates, please enter the number of pages of each item accompanying this form:

Continuation sheets of this form

Description

64

Claim(s)

Abstract

Drawing(s)

7 + 7 RM.

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for a preliminary examination and search (Patents Form 9/77)

Request for a substantive examination (Patents Form 10/77)

Any other documents (please specify)

11. I/We request the grant of a patent on the basis of this application.

Signature(s)

Murgitroyd & Company

Murgitroyd & Co.

Date 23 October 2003

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom

Graham Mumane

0141 307 8400

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Dated 23 November 2004

1 ROUTE GUIDANCE SYSTEM

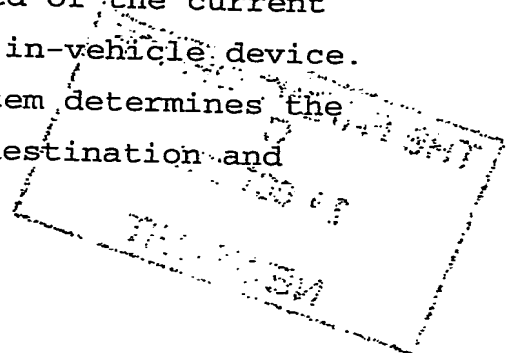
2

3 Background of the Invention

4 In-vehicle route guidance systems are known.
5 However, such systems typically include their own
6 on-board map databases. Since large amounts of data
7 are generally required to describe maps, traditional
8 in-vehicle route guidance systems generally include
9 storage devices with substantial storage capacities
10 to hold the relevant map data.

11

12 European Patent Application EP 1262936 describes a
13 route guidance system comprising an in-vehicle
14 device and a central route advisory system. EP
15 1262936 describes how the driver of a vehicle
16 contacts the central route advisory system and
17 indicates a required destination. The central route
18 advisory system is also informed of the current
19 position of the vehicle by the in-vehicle device.
20 The central route advisory system determines the
21 optimal route to the required destination and



1 transmits details of the route to the in-vehicle
2 device in a single compressed data message.

3
4 EP 1262936 further describes how during the journey,
5 the in-vehicle device issues audible instructions to
6 the driver as the vehicle passes route key-points
7 along the optimal route. The instructions advise
8 the user of future manoeuvres which the user will be
9 required to undertake at junctions, roundabouts etc.

10

11 Summary of the Invention

12

13 According to the invention there is provided a route
14 guidance system comprising an in-vehicle device and
15 a central route advisory system in which the in-
16 vehicle device comprises audio emitters and visual
17 display units adapted to provide audio and visual
18 instructions to a user to perform manoeuvres
19 required to complete an optimal route, wherein the
20 optimal route is transmitted by the central route
21 advisory system to the in-vehicle device in response
22 to a route request from the user to a human operator
23 in the central route advisory system to a specified
24 destination.

25

26 Preferably, the visual display unit is a monochrome
27 display.

28

29 Preferably, the visual display unit displays a
30 junction or roundabout as the vehicle approaches it.

31

1 Desirably, the visual display unit displays
2 junctions as pictographs.

3

4 Desirably, the visual display unit displays
5 roundabouts as pictographs.

6

7 Preferably, the visual display unit indicates the
8 required manoeuvre on the displayed pictograph.

9

10 Preferably, the visual manoeuvre instructions are
11 supplemented with audible manoeuvre instructions.

12

13 Desirably, the visual display unit provides a means
14 of initiating an automatic route request in respect
15 of a stored destination.

16

17 Desirably, the visual display unit displays the
18 proximity to speed-cameras.

19

20 Alternatively, the visual display unit is a colour
21 display unit.

22

23 Preferably, the colour display unit displays
24 coloured road-maps of a particular region.

25

26 Preferably, the colour display unit superimposes the
27 current position of the car on the road-map.

28

29 Preferably, the colour display unit superimposes the
30 pictograph of a junction or roundabout on a
31 displayed map.

32

1 Desirably, the colour display unit provides a user-
2 interface enabling the user to make telephone calls.

3
4 Desirably, the colour display unit provides a user-
5 interface enabling the user to receive telephone
6 calls.

7
8 Preferably, the colour display unit provides a user-
9 interface enabling the user to receive text-
10 messages.

11
12 According to a second aspect of the invention there
13 is provided a route guidance system comprising an
14 in-vehicle device and a central route advisory
15 system in which the in-vehicle device comprises
16 units adapted to provide instructions to a user to
17 perform manoeuvres required to complete an optimal
18 route, wherein the optimal route is determined by
19 the central route advisory system using real-time
20 historical traffic data acquired from monitored
21 routes together with archive data acquired from non-
22 monitored routes and transmitted by the central
23 route advisory system to the in-vehicle device in
24 response to a route request from the user to a human
25 operator in the central route advisory system to a
26 specified destination.

27
28 According to a third aspect of the invention there
29 is provided a route guidance system comprising an
30 in-vehicle device and a central route advisory
31 system in which the in-vehicle device comprises
32 units adapted to provide instructions to a user to

1 perform manoeuvres required to complete an optimal
2 route, wherein the optimal route is calculated by
3 the central route advisory system using a traffic
4 forecasting model and transmitted by the central
5 route advisory system to the in-vehicle device in
6 response to a route request from the user to a human
7 operator in the central route advisory system to a
8 specified destination.

9
10 Preferably, the traffic forecasting model is time
11 dependent.

12
13 Preferably, the central route advisory system
14 employs the time at which the route request was
15 received together with the time dependent traffic
16 forecasting model to predict future traffic
17 conditions.

18
19 According to a fourth aspect of the invention there
20 is provided a route guidance system comprising an
21 in-vehicle device and a central route advisory
22 system in which the in-vehicle device comprises
23 units adapted to provide instructions to a user to
24 perform manoeuvres required to complete an optimal
25 route, wherein the optimal route is calculated by
26 the central route advisory system taking into
27 account the previous travelling direction of the
28 vehicle, in response to a route request from the
29 user to a human operator in the central route
30 advisory system to a specified destination, and the
31 optimal route is transmitted by the central route
32 advisory system to the in-vehicle device.

1 According to a fifth aspect of the invention there
2 is provided a route guidance system comprising an
3 in-vehicle device and a central route advisory
4 system in which the in-vehicle device comprises
5 units adapted to provide instructions to a user to
6 perform manoeuvres required to complete an optimal
7 route, wherein the optimal route is calculated by
8 the central route advisory system taking into
9 account the previous travelling direction of the
10 vehicle, in response to a route request from the
11 user to a human operator in the central route
12 advisory system to a specified destination, and the
13 optimal route is transmitted by the central route
14 advisory system to the in-vehicle device.

15
16 According to a sixth aspect of the invention there
17 is provided a route guidance method comprising the
18 steps of:

- 19 (a) receiving a call from a user's in-vehicle
20 device indicating the user's desired
21 destination;
- 22 (b) entering the user's desired destination into a
23 route-guidance system;
- 24 (c) determining the current location of the user's
25 vehicle;
- 26 (d) determining the potential routes to the desired
27 destination;
- 28 (e) ascertaining traffic conditions along the
29 potential routes;
- 30 (f) determining the optimal route to the desired
31 destination using the distances of the

- 1 potential routes and the traffic conditions
- 2 along the routes;
- 3 (g) establishing route key-points along the optimal
- 4 route;
- 5 (h) associating flags with the route key-points;
- 6 (i) transmitting the route key-points and flags to
- 7 the user's in-vehicle device; and
- 8 (j) providing visual and audio instructions to the
- 9 user as the user's vehicle approaches the route
- 10 key-points along the optimal route.
- 11
- 12 According to a seventh aspect of the invention there
- 13 is provided a route guidance method comprising the
- 14 steps of:
- 15 (a) receiving a call from a user's in-vehicle
- 16 device indicating the user's desired
- 17 destination;
- 18 (b) determining the current location of the user's
- 19 vehicle;
- 20 (c) entering the user's desired destination into a
- 21 route-guidance system;
- 22 (d) determining the potential routes to the desired
- 23 destination;
- 24 (e) ascertaining traffic conditions along the
- 25 potential routes;
- 26 (f) determining the optimal route to the desired
- 27 destination using the distances of the
- 28 potential routes and the traffic conditions
- 29 along the routes;
- 30 (g) establishing route key-points along the optimal
- 31 route;
- 32 (h) associating flags with the route key-points;

- 1 (i) transmitting the route key-points and flags to
2 the user's in-vehicle device; and
3 (j) providing instructions to the user as the
4 user's vehicle approaches the route key-points
5 along the optimal route.

6
7 According to an eighth aspect of the invention there
8 is provided a route guidance method comprising the
9 steps of:

- 10 (a) receiving a call from a user's in-vehicle
11 device indicating the user's desired
12 destination;
13 (b) entering the user's desired destination into a
14 route-guidance system;
15 (c) determining the current location of the user's
16 vehicle from a dual multi-frequency tone
17 transmission from the user's in-vehicle device;
18 (d) determining the potential routes to the desired
19 destination;
20 (e) ascertaining traffic conditions along the
21 potential routes;
22 (f) determining the optimal route to the desired
23 destination using the distances of the
24 potential routes and the traffic conditions
25 along the routes;
26 (g) establishing route key-points along the optimal
27 route;
28 (h) associating flags with the route key-points;
29 (i) transmitting the route key-points and flags to
30 the user's in-vehicle device; and

1 (j) providing instructions to the user as the
2 user's vehicle approaches the route key-points
3 along the optimal route
4

5 Alternatively, the current position of the user's
6 vehicle is determined from an ISDN sub-addressing
7 transmission from the user's in-vehicle device.
8

9 According to a ninth aspect of the invention there
10 is provided a route guidance method comprising the
11 steps of:

- 12 (a) receiving a call from a user's in-vehicle
13 device indicating the user's desired
14 destination;
15 (b) entering the user's desired destination into a
16 route-guidance system;
17 (c) determining the current location of the user's
18 vehicle;
19 (d) determining the potential routes to the desired
20 destination;
21 (e) ascertaining traffic conditions along the
22 potential routes;
23 (f) determining the optimal route to the desired
24 destination using the distances of the
25 potential routes and the traffic conditions
26 along the routes;
27 (g) establishing route key-points along the optimal
28 route;
29 (h) associating flags with the route key-points;
30 (i) transmitting the route key-points and flags to
31 the user's in-vehicle device;

- 1 (j) using route convergence model to determine the
2 direction in which the user's vehicle is
3 travelling once the vehicle commences the
4 journey along the optimal route;
5 (k) providing visual and audio instructions to the
6 user as the user's vehicle approaches the route
7 key-points along the optimal route.

8
9 Preferably, the in-vehicle device uses the route
10 convergence model to display the current route on
11 which the vehicle is travelling.

12
13 Advantages of the Invention

14
15 Audible instructions of the type described in EP
16 1262936 can sometimes be ambiguous or misleading.
17 To overcome this problem, the present invention
18 includes display devices to provide visual aids to
19 supplement the audio instructions provided by the
20 in-vehicle device. These display devices also
21 provide the user with additional information such as
22 a distance count-down to a junction, estimated time
23 of arrival at a destination, proximity of speed
24 cameras etc.

25
26 A first embodiment of the invention includes a
27 monochrome display unit which displays junctions,
28 roundabouts etc. in simple pictographic format. The
29 second embodiment of the invention includes a colour
30 display unit which displays road-maps and depicts
31 the present location of the vehicle on the map. The
32 colour display unit also provides a user interface

1 which enables the user to make and receive voice
2 calls (other than to the call central route advisory
3 system) and to receive text messages.

4

5 The display units also provide user interfaces to
6 the route guidance system and enable a user to make
7 automatic route requests based on the post-code of a
8 destination, or previously stored favourite
9 destinations or previously visited destinations.

10

11 The first and second embodiments of the present
12 invention also includes a mechanism of encoding
13 pictograms representing junctions roundabouts etc.
14 in a data efficient manner so that the resulting
15 data can be readily transmitted to the user's in-
16 vehicle device.

17

18 The fifth embodiment of the present invention
19 employs a novel SMS messaging sequence to the call
20 centre advisory system.

21

22 EP 1262936 used SMS messaging to transmit the
23 vehicle's current GPS position to the central route
24 advisory system. Since SMS messaging may be
25 expensive, the sixth and seventh embodiments of the
26 present invention employ a less expensive dual-tone-
27 multi-frequency (DTMF) system and/or ISDN sub-
28 addressing mechanism for transmitting the vehicle's
29 current location to the central route advisory
30 system.

31

1 EP 1262936 described a route guidance system which
2 combined map information and historical and real-
3 time traffic information to determine the optimal
4 route to a required destination. However, the route
5 guidance system described in EP 1262936 relied
6 entirely on information acquired at the time at
7 which the route request was made. The system
8 described in EP 1262936 did not take into account
9 the fact that traffic conditions are dynamically
10 variable, so that the traffic conditions prevailing
11 at a particular point in time might not be
12 applicable an hour later. The fourth embodiment of
13 the present invention employs a time dependent
14 forecasting model to predict future traffic
15 conditions and in particular to predict the traffic
16 conditions that a driver might expect to encounter
17 on entering a particular route segment. The
18 forecast estimate is determined from the time at
19 which the route request is received by the central
20 route advisory system. The use of the time
21 dependent traffic forecasting model enables the
22 route guidance system to more accurately reflect the
23 dynamic nature of traffic flow.

24
25 Nine embodiments of the invention will now be
26 described with reference to the accompanying
27 drawings in which

28 Figure 1 is a block diagram of the in-vehicle
29 device showing the colour and monochrome display
30 units of the first and second embodiments of the
31 route guidance system;

1 Figure 2 is a block diagram of the hardware
2 components of the central call centre advisory
3 system of the routing guidance system;

4 Figure 3 is a schematic representation of an
5 example scenario demonstrating the function of a
6 confirmation point triplet;

7 Figure 4 is a schematic representation of an
8 example scenario demonstrating the function of
9 benign confirmation points;

10 Figure 5a is a pictogram of a roundabout as
11 would be displayed by the monochrome and colour
12 display units;

13 Figure 5b is a pictogram of a junction as would
14 be displayed by the monochrome and colour display
15 units;

16 Figure 6 is screen shot of the normal display
17 mode of the monochrome display units;

18 Figure 7 is a pictogram of bent variants of the
19 straight ahead arrow denoting bends on the route
20 ahead, as would be displayed by the monochrome and
21 colour display units;

22 Figure 8 is a series of pictograms of compound
23 junctions that would be displayed by the monochrome
24 and colour display units; and

25 Figure 9 is a screen shot of the compass aid
26 screen of the monochrome display unit.

27

28 The following description will first discuss the
29 hardware architecture of the route guidance system.
30 The role and function of route key-points in the
31 route guidance system will then be described
32 followed by a discussion of the route convergence

1 model and the smart start system. The description
2 will finally discuss the software architecture
3 employed in the first and second embodiments of the
4 invention which include the monochrome and colour
5 display units respectively.

6

7 HARDWARE ARCHITECTURE OF THE ROUTE GUIDANCE SYSTEM

8

9 As described in EP 1262936, the route guidance
10 system comprises in-vehicle devices and a central
11 route advisory system. An in-vehicle device is
12 installed in each user's vehicle and communicates
13 with the central route advisory system through a
14 mobile telephone network. An overview of the
15 architectures of the in-vehicle devices and the
16 central route advisory system will be discussed in
17 turn below.

18

19 Referring to Figure 1 and the first embodiment of
20 the route guidance system, an in-vehicle device 10
21 comprises a navigation unit 12 which in turn
22 comprises a GPS (Global Positioning System) receiver
23 14, a mobile telephone device 16 and a memory 19 for
24 the mobile telephone device 16. The navigation unit
25 12 further comprises a speech synthesiser 18, a
26 control microprocessor 22 and an on-board memory 20
27 for the speech synthesiser 18. The memory 20 for
28 the speech synthesiser 18 stores a variety of words
29 and phrases which acts as a vocabulary for the in-
30 vehicle device. The navigation unit 12 finally
31 comprises a memory for storing previous destinations
32 visited by the user 23.

1 The in-vehicle device 10 further comprises a
2 monochrome display unit 24 and its own on-board
3 memory 25. The memory 25 for the monochrome display
4 unit 24 stores the latitude and longitude details of
5 user-defined destinations.

6
7 The monochrome display unit 24 is a 128x64 pixel
8 FSTN LCD, although it will be appreciated that other
9 monochrome display devices could also be used. The
10 monochrome display unit includes a touch-screen
11 comprising eight fixed touch areas. The monochrome
12 display is back-lit with a blue LED edge light which
13 can be dimmed at night for safe viewing at night.
14 The contrast of the monochrome display is
15 automatically adjusted in response to changes in
16 ambient temperature. The monochrome display is
17 connected to the in-vehicle device by a bi-
18 directional RS232 interface and in use is further
19 connected to an ignition switched vehicle power
20 supply.

21
22 In the second embodiment of the route guidance
23 system, the monochrome display unit 24 and its
24 memory 25 is replaced with a colour display unit 26
25 and its memory 27. The colour display unit is 5.7
26 inch diagonal colour QVGA (320x240 pixel) STN LCD
27 incorporating a touch screen, although it will be
28 appreciated that other colour displaying devices
29 could also be used. The monochrome display unit
30 memory 25 and colour display unit memory 27 both
31 also store graphic elements used to construct

1 pictograms in accordance with encoded instructions
2 from the central route advisory system.

3
4 The monochrome display unit memory 25 and colour
5 display unit memory 27 both also store graphic
6 elements used to construct pictograms in accordance
7 with encoded instructions from the central route
8 advisory system.

9
10 Referring to Figure 2, the central route advisory
11 system 30 comprises a navigation server 32, an
12 extraction server 33 and a traffic server 34. The
13 navigation server 32 calculates an optimal route to
14 a destination on receipt of a user request. The
15 optimal route is determined using data from the
16 traffic server 34. The navigation server 32 then
17 transmits details of the optimal route to the
18 extraction server 33 which formats the data for
19 transmission to the user's in-vehicle device as a
20 compressed data message.

21
22 Looking at the relationship between the navigation
23 server 32 and the extraction server 33 in more
24 detail, the navigation server 32 typically expresses
25 a calculated optimal route in NavML (or other
26 suitable route engine output). The extraction
27 server 33 then extracts the relevant information
28 from the NavML (or other suitable route engine
29 output) stream to construct a route_summary message
30 and encodes it for wireless transmission to the
31 user's in-vehicle device.

32

1 Route_summary messages typically include a set of
2 GPS positions of route key-points along the optimal
3 route. In general a number of the route key-points
4 are included in any optimal route spaced at
5 intervals of approximately 1 mile. In particular,
6 route key-points are included at positions along the
7 route where an instruction must be given to the
8 driver, or at positions where it might be possible
9 for a driver to make a wrong-turning or take the
10 wrong exit from a roundabout etc. and thereby
11 deviate from the optimal route.

12
13 As part of the audio-prompting mechanism of the
14 route guidance system, Route_summary messages
15 typically also include a number of flags or tokens
16 which are associated with individual route key-
17 points. The flags are used for selecting individual
18 words or phrases from the in-vehicle device's on-
19 board memory and playing the words or phrases to the
20 driver. The flags trigger the selection and playing
21 of a word or phrase as the vehicle passes an
22 associated route key-point. Consequently complete
23 sentences can be constructed as the vehicle passes
24 successive route key-points.

25
26 A description of the role and function of route key-
27 points will follow the description of the hardware
28 architecture of the route guidance system.

29
30 In the first and second embodiments of the route
31 guidance system, a route-message typically uses
32 information extracted from the NavML (or other

1 suitable route engine output) stream to encode
2 pictograms representing junctions and roundabouts on
3 the calculated optimal route.

4
5 For example, if the optimal route includes a
6 roundabout, details of the roundabout including its
7 structure, required entrance and exit are
8 transmitted in NavML form (or other suitable route
9 engine output) by the navigation server 32. The
10 extraction server 33 extracts the relevant
11 information from the NavML (or other suitable route
12 engine output) stream and encodes it for
13 transmission to the in-vehicle device. The encoding
14 process involves representing the roundabout with a
15 specific binary code recognised by the in-vehicle
16 device.

17
18 As indicated above, the monochrome and colour
19 display unit memory chips 25 and 27 store specific
20 graphic elements for constructing pictograms. In
21 the case of the roundabout example, on receipt of
22 the roundabout identifier from the extraction server
23 33, the display unit memory chips 25 and 27 retrieve
24 the circular graphic component used for representing
25 roundabouts.

26
27 The roundabout graphic element has twelve slots
28 about its circumference. On receipt of a code
29 identifying the required entrance to the roundabout,
30 a linear graphic element is inserted in the circular
31 graphic element at slot zero. Using a clock as an
32 analogy for the circular graphic element, slot zero

1 is located at the six o'clock position. This leaves
2 eleven remaining slots for depicting the potential
3 exits from the roundabout. Linear graphic elements
4 are retrieved from the monochrome and colour display
5 unit memory chips 25 and 27 and positioned in slots
6 around the circular graphic element moving in a
7 generally clockwise direction according to the
8 specific binary instructions transmitted by the
9 extraction server 33. A further code is transmitted
10 by the extraction server 33 to specifically identify
11 the required exit from the roundabout. A similar
12 process is used for encoding and depicting radial
13 junctions.

14

15 Route_messages also typically include textual
16 entries for the names of the required entry and exit
17 roads from any junctions on the optimal route.

18

19 In terms of the architecture of the central route
20 advisory system 30, the navigation server 32
21 communicates with a traffic repository 36 which
22 stores historical traffic information and road
23 closures data. Historical data is data which has
24 been compiled over a period of time to reflect
25 changes in traffic patterns that occur depending
26 upon the time of day or the day of the month in
27 question (e.g. rush hour traffic varying by day of
28 week and season).

29

30 The navigation server 32 also communicates with an
31 application programming interface (API) 40. The API
32 40 facilitates communication between the navigation

server 32 and a map database 42 via requests and responses. The map database 42 contains map data together with real time traffic information and historical traffic information. In effect, the navigation server 32 calculates an optimal route for a user, taking into account the distances to be travelled along different routes and traffic conditions along the routes. Traffic conditions are used to estimate the speed at which a vehicle might be expected to travel along a candidate route and thus the delay that a driver might experience along that route. The inclusion of traffic condition information into the algorithm for determining the user's optimal route is known as "traffic impacted routing".

In a fourth embodiment of the route guidance system, the route optimisation calculations performed by the navigation server are further enhanced by the use of a time dependent traffic forecasting model. The traffic forecasting model forecasts the traffic conditions that might be expected along a route segment depending upon the time at which a route request was received (T_{req} 44). The forecasting model is designed to be time dependent, so that it can more accurately reflect the dynamic and time-varying nature of traffic congestion.

Using the time dependent traffic forecasting model, the navigation server adjusts the speeds at which the user might be expected to travel along candidate route segments according to the traffic conditions

1 that might be expected to exist along these route
2 segments. As mentioned above the traffic conditions
3 are forecasted based on the time at which a route
4 request is received (T_{req} 44).

5
6 As a simple example, consider a journey at 5 p.m.
7 for which there are two potential routes to the
8 required destination (i.e. Route_A and Route_B).
9 Suppose Route_B is longer than Route_A. However, let
10 us also suppose that during rush-hour (i.e. 5 p.m.)
11 Route_A is considerably busier than Route_B. In this
12 circumstance a driver might be expected to travel
13 more slowly on Route_A than they might on Route_B.
14 Consequently, whilst Route_B might be longer than
15 Route_A the driver might nonetheless have a journey of
16 shorter duration taking Route_B rather than Route_A.

17
18 Looking at the time dependent traffic forecasting
19 model in more detail, the model generates a forecast
20 from data contained in an averaged historical
21 traffic archive together with a forward calendar.
22 The records contained in the averaged historical
23 traffic archive represent average traffic conditions
24 measured over an extended period (e.g. showing
25 differences between week-day and weekend traffic
26 conditions along a particular route segment). The
27 forward calendar is used by the forecast model to
28 select a record from the historical traffic archive
29 that is most relevant to the date at which the route
30 request is made. The forward calendar can also be
31 used as part of a long-term forecasting system if a
32 route request is made in respect of a future date.

1 A short-term forecast of the expected traffic
2 conditions along a candidate route segment is made
3 by the forecasting model using the selected
4 historical traffic record together with the time at
5 which the route request is made (T_{req} 44) and the
6 real-time current traffic conditions recorded at the
7 time the route request was made.

8
9 In a third embodiment of the invention, the
10 navigation server 32 also communicates with a
11 typical traffic information (TTI) database 38. TTI
12 refers to traffic information relating to un-
13 monitored routes e.g. non-trunk A roads, minor roads
14 and urban streets. The TTI database 38 contains a
15 static data-set that can be used by the navigation
16 server 32 to calculate optimal routes for any time
17 of any day.

18
19 The data contained in the TTI database 38 are
20 equivalent to the data provided for the monitored
21 roads by the long-term forecast. As there is no
22 real-time data for these roads this data is not
23 updated in real-time to produce a more accurate
24 short-term forecast for these route segments.
25 However, the TTI data can be over-ridden on the
26 occurrence of specific traffic events.

27
28 Without the use of the time-dependent traffic
29 forecasting model, the navigation server 32 can only
30 base its route calculations on the conditions of the
31 route at the time of calculating the route.
32 Clearly, such route calculations do not consider the

1 changes in the traffic conditions on a given route
2 segment that might have occurred between the time of
3 the original route calculations and the time at
4 which the driver reaches the route segment in
5 question.

6
7 In addition to providing route information, the
8 central route advisory system 30 can provide a user
9 with traffic congestion information. Traffic
10 congestion information is acquired by the traffic
11 server from a variety of sources such as roadside
12 speed cameras and traffic reports.

13
14 The traffic server 34 communicates real time traffic
15 information and historical traffic information to
16 the navigation server 32 and additionally transmits
17 historical traffic information to a historical
18 traffic information database 46.

19
20 The historical traffic information database 46
21 provides a map compiler 48 with historical traffic
22 information. The map compiler 48 formats map data
23 together with real time traffic information and
24 historical traffic information and the standard
25 speed for a given road link. The map compiler 48
26 transmits this information to the map database 42
27 which in effect contains standard default expected
28 speeds (impedances) along road-links.

29
30 The traffic server 32 also communicates with a users
31 database 50. The users database 50 stores user
32 profile data (e.g. user's name & address etc.).

1 This data can be amended in accordance with user's
2 requirements (e.g. by the user through an internet
3 connection or by customer services representatives).
4

5 Taking a more detailed look at the relationship
6 between the in-vehicle device 10 and the central
7 route advisory system 30, in use, a user may use the
8 in-vehicle device 10 to manually contact a call
9 centre operator at the central route advisory system
10 30 and provide his required destination. The
11 operator then supplies the required destination to
12 the navigation server 32.
13

14 The system employs two different approaches to
15 transmitting the vehicle's current position. In the
16 first approach whilst the user is speaking to the
17 call-centre operator, the in-vehicle device's
18 navigation unit transmits its calling line identity
19 (CLI) and the current GPS position of the vehicle in
20 an SMS message to the navigation server 32. The
21 advantage of transmitting the navigation unit's CLI
22 before the voice-call is established is that the SMS
23 message containing the CLI has more time to reach
24 the navigation server 32. However, the disadvantage
25 of this approach is that there is a delay in the
26 establishment of the voice-call. In a fifth
27 embodiment of the route guidance system, a second
28 approach is employed in which the navigation unit
29 transmits the SMS message to the navigation server
30 32 before the voice-call is set up between the
31 driver and the call-centre operator. The advantage
32 of this approach is that there is less delay in

1 establishing a voice-call to a call-centre operator.
2 However, more of the duration of the voice-call is
3 taken up with transmitting the CLI to the navigation
4 server than with the first approach.

5
6 On receipt of the route request, the navigation
7 server 32 calculates the optimal route to the
8 required destination, taking into account the user's
9 preferences and traffic conditions, particularly
10 traffic congestion. As discussed above, the
11 navigation server 32 may also use a time-dependent
12 traffic forecasting model to determine the optimal
13 route for the user.

14
15 The navigation server 32 then transmits a response
16 to the optimal route query in a NavML (or other
17 suitable route engine output) stream to the
18 extraction server 33. The extraction server 33
19 extracts the relevant information from the NavML (or
20 other suitable route engine output) stream and
21 encodes into a compressed data message suitable for
22 wireless transmission to the in-vehicle navigation
23 unit. The compressed data message includes all the
24 route key-points on the optimal route together with
25 flags at associated route key-points for triggering
26 audible manoeuvre prompts to the user. In the case
27 of the first and second embodiments of the route
28 guidance system, the compressed data message also
29 includes encoded pictograms and textual information.

30
31 The communications channel between the in-vehicle
32 device and the central route advisory system 30 is

1 then closed and the extraction server 33 does not
2 communicate any further with the in-vehicle device
3 unless the driver requests a different route to the
4 same or a different destination or traffic
5 conditions have changed since the original route
6 request.

7
8 As described above, as the vehicle progresses along
9 the optimal route and passes individual route key-
10 points a flag may be activated triggering the
11 selection of a word or phrase from the in-vehicle
12 device's on-board memory. The word or phrase is
13 then played to the driver through the speech
14 synthesiser to provide audible prompts of required
15 manoeuvres, oncoming junctions etc..

16
17 In the first and second embodiments of the route
18 guidance system, as the vehicle progresses along the
19 optimal route and passes individual route key-
20 points, pictograms displaying nearby junctions or
21 roundabouts are displayed on the in-vehicle device's
22 monochrome or colour display units, together with
23 visual indications of the required manoeuvre and the
24 names/numbers of the entry and exit routes from the
25 junction or roundabout in question. Further
26 discussions of the manner in which junctions and
27 roundabouts are displayed will follow in the
28 discussion of the software architectures of the
29 monochrome and colour display units.

30
31 Returning to the manner in which the in-vehicle
32 device transmits a route request to the central

1 route advisory system 30, since SMS messaging may be
2 costly, the in-vehicle navigation unit may use two
3 less costly, alternative means of transmitting the
4 current GPS position of the vehicle. In the sixth
5 embodiment of the route guidance system, the
6 navigation unit transmits the GPS position of the
7 vehicle to the navigation server 32 using dual-tone-
8 multi-frequency (DTMF) tones at the start of the
9 user's voice-call to the central route advisory
10 system 30.

11
12 In the seventh embodiment of the route guidance
13 system, the in-vehicle navigation unit transmits the
14 vehicle's current GPS position to the navigation
15 server 32 using ISDN sub-addressing as the voice-
16 call to the central route advisory system 30 is
17 being set up. ISDN sub-addressing may be used for
18 this purpose because the ISDN specification allows
19 for additional characters to be appended to a called
20 telephone number. These characters are usually used
21 for further call routing once a call is connected.
22 However, the number of extra characters that may be
23 appended to a called telephone number is also
24 sufficient to enable the transmission of an encoded
25 geographic location.

26
27 All of the above methods of transmitting a route
28 request to the central route advisory system 30 have
29 relied upon a manual process of establishing a
30 voice-call to the call-centre advisory system and
31 telling the call-centre operator the required
32 destination, whereupon the operator manually enters

1 the required destination into the navigation server
2 32.

3
4 In addition to the above manual voice-call based
5 route request process, the route guidance system can
6 also support a process for automatically making a
7 route request. In particular, the user can use the
8 in-vehicle navigation unit to automatically send a
9 route request for a required destination to the
10 central call centre advisory system navigation
11 server by using the favourites function or previous
12 destination function.

13

14 ROLE AND FUNCTION OF ROUTE KEY-POINTS

15

16 Route key-points can be classified as preparation
17 points, warning points, instructions points,
18 manoeuvre points and confirmation points. A
19 preparation point is positioned along a selected
20 route before a location where a manoeuvre must be
21 performed by the user to reach the required
22 destination. The purpose of the preparation point
23 is to provide a warning to a driver to prepare to
24 perform the required manoeuvre. A typical audio
25 prompt for a preparation point would be "prepare to
26 turn left in 6 yards".

27

28 A warning point is positioned closer to the location
29 of the required manoeuvre than a preparation point.
30 A warning point similarly serves to warn the driver
31 that he will be required to perform a manoeuvre
32 soon. However, it should be noted that in the case

1 where a driver might be required to perform a series
2 of manoeuvres within a short distance of each other
3 it might not be possible to place a preparation
4 point and warning point before each manoeuvre.
5

6 An instruction point is placed very close to the
7 location where the required manoeuvre must be
8 performed. A typical audio prompt for an
9 instruction point would be "Please turn left".
10

11 A manoeuvre point is a point along the prescribed
12 route where a manoeuvre must be performed by the
13 driver. These points are used internally by the
14 route guidance system and no instructions are given
15 to the driver as they pass these points.
16

17 There are two forms of confirmation points, spoken
18 and non-spoken. A spoken confirmation point
19 provides audible confirmation to the driver that
20 they have completed a required manoeuvre correctly.
21 A typical spoken confirmation point prompt might be
22 "continue driving for 5 yards".
23

24 A non-spoken confirmation point does not provide an
25 audible prompt to the driver, but instead is used by
26 the route guidance system to ensure that the vehicle
27 is being driven along and has not deviated from the
28 prescribed optimal route.
29

30 Looking firstly at spoken confirmation points, take
31 for example, the situation shown in Figure 3. In
32 this example a car 50 is travelling along a main

1 road 52 from which there are a number of side-roads
2 54a, 54b and 54c. The prescribed optimal route
3 requires the driver of the car 50 to continue along
4 the main road 52. Thus if the driver drives the car
5 50 onto one of the side roads 54a, 54b or 54c, the
6 car will no longer be following the prescribed
7 optimal route and can be said to be "off-route".

8
9 In order to determine whether or not a car has been
10 driven "off-route" (onto one of the side roads), a
11 set of three confirmation points (known as a CP
12 triplet) is positioned around each of the junctions
13 with the side-roads. The CP triplet is designed so
14 that a first confirmation point CP_1 is situated
15 before each junction and the two remaining
16 confirmation points CP_2 and CP_3 are positioned after
17 each junction with CP_2 being positioned closer to
18 the junction than CP_3 .

19
20 CP_1 is known as a pre-junction confirmation point
21 and CP_2 and CP_3 are collectively known as post-
22 junction confirmation points. Two post-confirmation
23 points are used in the CP triplet to introduce
24 redundancy into the "off-route" detection system to
25 cope with mapping and GPS errors in the system. For
26 the example shown in Figure 3, the CP triplet
27 associated with each side road 54a, 54b and 54c are
28 designated with a, b and c superscripts
29 respectively.

30
31 Returning to the example shown in Figure 3, as
32 mentioned previously the car 50 is being driven

1 along main road 52 and is approaching the side road
2 54b. If the car 50 passes CP_1^b and CP_2^b or CP_3^b , it
3 is clear that the vehicle is correctly following the
4 optimal route and has not been driven down the side
5 road 54b. However, if the car 50 passes CP_1^b , but
6 does not pass CP_2^b or CP_3^b , it is clear that the car
7 50 has been driven onto side road 54b and is thus
8 "off-route". In this circumstance, the in-vehicle
9 device issues a prompt to the driver warning him
10 that he has driven off the prescribed optimal route.
11

12 Having so far described the role of spoken
13 confirmation points in CP triplets, the description
14 will now turn to the role of non-spoken confirmation
15 points.

16
17 Consider, for example, the situation shown in Figure
18 4 in which a car 60 is parked by the side of a road
19 62. The road ends in a T-junction 64 and the
20 prescribed optimal route requires the driver to turn
21 left onto the T-junction 64. Under normal
22 circumstances a preparation point, warning point and
23 instruction point would have been positioned before
24 the T-junction, to warn the driver that he is
25 approaching the junction and advising the driver of
26 which direction to turn at the junction. However,
27 given the limits to the resolution of domestically
28 available GPS, it is conceivable that the car 60
29 might have been parked at a position 66 between the
30 instruction point for the T-junction 64 and the
31 manoeuvre point representing the T-junction 64
32 itself. In this case, the driver would not receive

an instruction as to which direction to turn at the T-junction 64. To overcome this problem, multiple confirmation points CP_1 to CP_n are spaced at close intervals along the road 62. The route message summary transmitted to the in-vehicle device from the central route advisory centre includes a flag for each of the confirmation points indicating that the driver should be advised to "turn left at the junction". Consequently, even though the car might miss the preparation, warning and instruction points for the junction, the driver will nonetheless receive instructions as to which direction to turn on the junction.

However, since there may be several confirmation points located between the original parking position 66 of the car 60 and the T-junction 64, it would be undesirable to have the same "turn left at the junction" message repeatedly played to the driver as the car 60 passes each of these confirmation points. To overcome this problem, as the car 60 passes the first confirmation point after the parking position 66, the driver is prompted to "turn left at the junction" and the remaining confirmation points on the road 62 are converted into non-spoken confirmation points, so that the prompt is not sent to the driver again as the car 60 passes the remaining confirmation points to the T-junction 64. Such non-spoken confirmation points are also known as "benign" confirmation points. An exception to this procedure exists if the vehicle is required to drive across a main road to reach the T-junction. In

1 this case a warning is issued to the user as he
2 approaches the main road.

3

4 THE SMART START SYSTEM AND BRANCH CONVERGENCE MODEL
5

6 As discussed above, any route from a first location
7 to a second location is characterised by the route
8 guidance system by a number of route key-points
9 which include locations at which specific manoeuvres
10 must be performed by the driver (e.g. turn right at
11 the T-junction etc.) or locations at which the
12 progress of a vehicle can be checked to determine
13 whether the vehicle is still on the correct route.

14

15 In general, from any particular starting point there
16 may be many different alternative routes or
17 "branches" to the required destination. As the
18 journey progresses the number of alternative routes
19 to the destination steadily decrease, until all the
20 alternative routes eventually converge into a single
21 "onward route" to the destination. Since each
22 alternative route is characterised by a set of route
23 key-points, the start of any journey is similarly
24 characterised by the presence of a number of
25 different sets of route key-points, one for each
26 alternative route to the destination. As the
27 journey progresses, the process of route convergence
28 is reflected in a steady decrease in the number of
29 sets of route key-points which can be used to
30 describe the journey.

31

1 Consider for example, a car parked on a street. The
2 car may be pointed in one of two directions on the
3 street and thus there are two directions in which
4 the car may progress down the street from its
5 parking position (and thus two potential branches
6 from the starting position). If the car passes a
7 route key-point situated at either end of the street
8 it is possible to determine in which direction the
9 car is travelling and thus the branch corresponding
10 to the direction in which the car did not travel
11 disappears.

12

13 SOFTWARE ARCHITECTURE OF THE FIRST AND SECOND
14 EMBODIMENTS OF THE ROUTE GUIDANCE SYSTEM

15

16 (A) MONOCHROME DISPLAY UNIT SOFTWARE

17

18 The main purpose of the monochrome display unit is
19 to provide user guidance to a user to supplement the
20 audible instructions issued by the in-vehicle
21 device.

22

23 The monochrome display unit has a number of
24 different display modes including a normal display,
25 a compass display, a menu display and a guidance
26 inactive display. These display modes will be
27 described in more detail below.

28

29 (1) Normal Display Mode

30

31 The information displayed by the monochrome display
32 unit consists primarily of graphical icons

1 representing junctions and roundabouts etc. as seen
2 in Figures 5a and 5b. The purpose of such displays
3 is to clarify ambiguous audible instructions issued
4 by the in-vehicle device.

5
6 The normal screen displayed by the monochrome
7 display unit is shown in Figure 6 and comprises four
8 main sections, namely a target/current road section
9 100, a junction pictogram/straight ahead arrow
10 section 102, a distance countdown section 104 and an
11 information zone section 106. These sections will
12 be described in more detail below.

13
14 (i) Target/Current Road Section 100

15 This section shows the number and/or name of the
16 road that the vehicle is currently on and the number
17 and/or name of the road onto which the vehicle
18 should turn during a manoeuvre. When driving
19 straight ahead the current road will be shown.

20
21 (ii) Junction Pictogram/Straight Ahead Arrow Section
22 102

23
24 This section displays a pictogram depicting a
25 roundabout or radial junction such as those shown in
26 Figures 5a and 5b. The display is initiated when
27 the vehicle passes a preparation point and continues
28 to be displayed during the subsequent manoeuvre.

29
30 When driving straight ahead, an arrow symbol is used
31 instead of the roundabout/radial junction pictogram.
32 The arrow symbol can be displayed in a variety of

1 curved forms as shown in Figure 7 to reflect changes
2 in road direction.

3

4 Both the radial and roundabout pictograms comprise a
5 central point from which 12 branches are disposed at
6 30° degrees angle relative to each other. The
7 required route through the roundabout or radial
8 junction is highlighted on the pictogram.

9

10 The monochrome display unit also displays pictograms
11 depicting compound junctions, such as those seen in
12 Figure 8. These pictograms essentially comprise
13 assemblies of the roundabout and radial junction
14 pictograms previously discussed.

15

16 If the navigation unit of the in-vehicle device
17 detects that the vehicle has passed an appropriate
18 confirmation point, it is clear that the driver has
19 correctly completed the required manoeuvre and the
20 junction pictogram is replaced by the straight ahead
21 pictogram.

22

23 (iii) Distance Countdown Section 104

24 This section provides a graphical and/or numeric
25 representation of the remaining distance until a
26 manoeuvre is to be executed (the "manoeuvre point").

27

28 (iv) Information Zone 106

29 This section is used to display the estimated
30 time of arrival (ETA) and distance to the required
31 destination This section can also be used to
32 display warnings to the driver of oncoming speed

1 cameras and to indicate the speed limit in the
2 vicinity of a speed camera.

3

4 (2) Compass Display Mode
5

6 At the start of a journey, or in the event that a
7 vehicle deviates from the prescribed optimal route.
8 The normal display (described above) is changed to a
9 "compass" type display as shown in Figure 9
10 comprising an arrow shaped indicator (the compass
11 arrow) of the direction of travel.
12

13 If the vehicle is starting a journey, the compass
14 arrow points towards the first route key-point on
15 the prescribed optimal route and the display
16 provides an indication of the distance to this point
17 and its associated road name.

18

19 As described in an earlier example, in the case of a
20 car starting a journey from a position parked by the
21 side of a road, it is not possible to determine the
22 direction in which the car is pointed and thus,
23 until the vehicle has moved it is not possible to
24 determine the direction in which it is travelling.
25 In this circumstance, the most recent travel
26 direction of the car prior to the present journey is
27 stored by the in-vehicle device and used to
28 calculate the direction in which the compass arrow
29 on the monochrome display should point.

30

31 In the case where a vehicle has deviated from a
32 prescribed optimal route, the compass arrow points

1 towards the final destination point and an "off
2 route" warning is displayed instead of the road-name
3 of the next route key-point on the prescribed
4 optimal route.

5

6 (3) Menu Display Mode

7

8 The touch screen of the monochrome display unit acts
9 as a user interface to the in-vehicle device.
10 Touching the screen activates a menu of functions
11 including:

- 12 (i) Call centre
- 13 (ii) Advanced guidance
- 14 (iii) Mute
- 15 (iv) Repeat
- 16 (v) SOS

17

18 (i) Call Centre

19 Activating the call centre function initiates a
20 manual route-request to the call centre advisory
21 system.

22

23 (ii) Advanced Guidance

24 The advanced guidance menu option provides access to
25 a sub-menu containing additional guidance-related
26 options including:

- 27 (a) Presets 1 to 9
- 28 (b) Re-route
- 29 (c) Cancel
- 30 (d) Suspend/Resume

31

1 These options will be discussed in more detail
2 below.

3

4 (a) Presets 1 to 9

5 This option allows the selection of destinations
6 that have been preset via a web site.
7 Selecting a destination, causes the in-vehicle
8 device to send an automated request to the call
9 centre advisory system for a route to the
10 destination .

11

12 (b) Re-route

13 The re-route option allows a user to invoke a
14 routing call to determine a new route to the
15 currently selected destination. If guidance to the
16 destination is not already in progress, the re-route
17 option is inactivated.

18

19 (c) Cancel

20 This option enables a user to abandon route
21 guidance.

22

23 (d) Suspend/Resume

24

25 Selecting the suspend option causes the in-vehicle
26 device to mute guidance and traffic related audible
27 instructions and suppress pictograms and re-routing
28 advice. In the meantime, the in-vehicle device
29 continues to scan and match route key-points along
30 the prescribed optimal route.

31

32

33

1 (iii) Mute

2 This option silences any audible prompt that is
3 being issued by the in-vehicle device.

4

5 (iv) Repeat

6 This option repeats the last audible prompt issued
7 by the in-vehicle device.

8

9 (v) SOS

10 The SOS option allows a user to make a voice call to
11 a preset emergency and/or breakdown telephone
12 number.

13

14 (4) Inactive Guidance Display Mode

15 When the user has not requested route guidance (i.e.
16 guidance is inactive), the monochrome display
17 provides general information to the user. The
18 information displayed by the monochrome display unit
19 in such circumstances includes

20 (a) the current time

21 (b) speed camera warnings

22 (c) a graphical compass depicting the current
23 direction of travel.

24

25

26 (B) COLOUR DISPLAY UNIT SOFTWARE

27

28 In common with the monochrome display unit, the
29 colour display unit is designed to provide visual
30 prompts to a driver to supplement the audible
31 instructions issued by the in-vehicle device.

32

1 The colour display unit is capable of displaying
2 much more sophisticated graphics than the monochrome
3 display unit and in particular is not restricted to
4 pictographic displays but is also capable of
5 displaying coloured road maps showing the relative
6 position of the vehicle and nearby roundabouts and
7 junctions

8
9 As with the monochrome display unit, the colour
10 display unit has a number of display modes.
11 However, regardless of which display mode is
12 activated on the colour display unit, there is
13 always an area reserved at bottom of screen for
14 displaying:

- 15 (a) the remaining distance to the destination
- 16 (b) the estimated time of arrival at the
17 destination
- 18 (c) an indication of whether traffic
19 congestion has been detected within the
20 map area displayed on the screen at any
21 given time

22

23 The display modes of the colour display function
24 include:

- 25 (A) Map Display Mode
- 26 (B) Guidance Active Mode
- 27 (C) Guidance Inactive Mode
- 28 (D) Help Mode

29

30 The display modes will be described in more detail
31 below.

32

(A) MAP DISPLAY MODE

The principal display mode of the colour display unit is the map display mode. The colour display unit operates in map display mode even if the in-vehicle device does not contain a navigation unit. If the in-vehicle device does not contain a navigation unit the colour display unit does not display any navigation options. When operating in map display mode, the colour display unit displays a road map of the relevant country which can be zoomed to different degrees of magnification in accordance with user demands. In particular, the road maps can be displayed at magnifications between 0.4 pixels per mile (in which the entire UK mainland displayed on the screen) and 100 pixels per mile (wherein the screen width covers approximately 3 miles). At higher levels of magnification, the map display shows motorway and trunk road networks and additional less significant roads.

MAP DISPLAY MODE MENUS

A number of functions are available to the user when the colour display unit is operating in map display mode, these functions can be divided into

- (1) basic functions
- (2) advanced functions
- (3) telephone functions

The advanced functions include the following:

- (a) a live traffic information function;

- 1 (b) a current route display function;
- 2 (c) a junction display function;
- 3 (d) a compass aid function,
- 4 (e) an exit indicator function; and
- 5 (f) a safety camera warning function.

6 All the functions will be described in more detail
7 below.

8

9

1. BASIC MAP DISPLAY MODE FUNCTIONS

10

11 The basic map display mode functions include a
12 vehicle location information function and an auto-
13 locate function. Both basic map display functions
14 will be described in turn below.

15

16 (a) Vehicle Location Information

17 If a navigation unit is installed in the in-vehicle
18 device, the navigation unit can determine the GPS
19 location of the vehicle. The current GPS co-
20 ordinates of the vehicle are used to position a
21 vehicle icon on the currently displayed map, at a
22 point reflecting the current position of the vehicle
23 in relation to the map. The navigation unit can
24 also use acquired GPS data to determine whether or
25 not the vehicle is moving. If the vehicle is moving
26 the vehicle icon displayed on the current map is
27 depicted with an indication of the direction of
28 movement.

29

30 If the navigation unit cannot obtain a valid GPS fix
31 and thereby determine the current location of the
32 vehicle, the vehicle icon is displayed in accordance

1 with the most recent previously determined GPS
2 location of the vehicle. Vehicle icons are displayed
3 in one of two colours to enable a driver to
4 distinguish between vehicle icons displayed using a
5 current GPS fix and those using a previous GPS fix.

6
7 At all levels of zoom apart for the outermost (whole
8 of the relevant country), the map display is
9 provided with a pan option which enables the map to
10 be panned at the same level of zoom in one of eight
11 directions. To facilitate the panning operation, a
12 set of eight pan arrows is always displayed on a
13 map.

14
15 (b) Auto-Locate Function

16 In order to reduce the amount of required
17 interaction between the driver and the controls of
18 the colour display unit, the auto-locate function
19 can be used to automatically pan a displayed map, so
20 that the map tracks the location of the vehicle in
21 accordance with the most recently acquired GPS fix
22 of the vehicle.

23
24 When the auto-locate function is initiated, the user
25 may manually pan a displayed map until the
26 navigation unit obtains a first valid GPS fix for
27 the vehicle. Once a valid GPS fix is obtained, the
28 map is automatically panned so that vehicle is
29 positioned at the centre of the screen. If the
30 vehicle moves, the map is automatically panned to
31 keep the vehicle icon centred on the screen. The
32 zoom level of the map may be changed at any time

1 whilst the auto-locate function is activated, and
2 the auto-scrolling of the map will continue in
3 accordance with the movement of the vehicle.

4
5 If the auto-locate function is de-activated, the map
6 display will continue to update the vehicle position
7 on the map, but the map will no longer be
8 automatically panned in accordance with the movement
9 of the vehicle. Consequently depending on the
10 movement of the vehicle, the vehicle may move
11 outside the range of the currently displayed map, in
12 which case the vehicle icon will disappear from the
13 map display, unless the user manually pans the map
14 to compensate for the movement of the vehicle.

15
16 If the auto-locate function is not enabled, a
17 displayed map can be panned manually to track the
18 movement of the vehicle.

20 2. ADVANCED DISPLAY MODE FUNCTIONS

22 (a) Live Traffic Information Function

23
24 Traffic congestion is shown on a currently displayed
25 map using icons superimposed on the corresponding
26 locations on the map. The colour of a congestion
27 icon represents the degree of congestion at the
28 particular location relative to the free-flowing
29 traffic state. The number of congestion icons and
30 their distribution on a map indicate the extent of
31 the congestion within the geographical area
32 encompassed by the displayed map. The congestion

1 icon can also include a numeric representation of
2 the average speed of traffic at the affected
3 location, or alternatively a numeric representation
4 of the delay to be expected at the affected
5 location.

6
7 Congestion icons are designed to flash when
8 superimposed on a displayed map, to attract the
9 driver's attention and reveal map detail which may
10 be concealed beneath the icons. All of the
11 displayed congestion icons flash at the same rate.
12 However, when there are delays in both directions at
13 a particular location, the flashing of oppositely
14 disposed icons is sequenced, so that the congestion
15 in each direction is shown separately.

16
17 If a map were to be displayed at a low magnification
18 (i.e. low level of resolution) a normal congestion
19 icon might be shrunk to the extent that it would be
20 too small to be noticed by the driver. To overcome
21 this problem, a specialised LED style congestion
22 icon is used on maps displayed at low magnification.
23 Such LED style congestion icons do not contain
24 numerical information, but are instead colour coded
25 in accordance with the degree of traffic congestion
26 at a particular point.

27

28 (b) Current Route Display Function

29

30 When a route has been downloaded to the in-vehicle
31 device it is displayed as a highlighted trace
32 superimposed on the currently displayed map.

1 Routing information may include roads that are not
2 held in the colour display unit map database and
3 these will be plotted based on vectors supplied by
4 the in-vehicle device's navigation unit. Once the
5 plotted journey is underway the highlighting on the
6 route will be greyed-out as the vehicle proceeds
7 along it.

8
9 In a ninth embodiment of the route guidance system,
10 the current route display function is intimately
11 linked with the previously described smart start
12 system and route convergence model. In order to
13 plot the current route of a vehicle, at any given
14 route key-point it is necessary to select and
15 display the branch which most closely reflects the
16 most recent manoeuvres of the vehicle.
17 Consequently, the current route display function
18 employs a dynamic selection and replotting algorithm
19 to provide a real-time display of the most suitable
20 route for the vehicle to its destination. The
21 process of selecting the most suitable branch for
22 the vehicle can be very broadly described in terms
23 of the following steps:

- 24 (i) Before the navigation unit has determined
25 that the vehicle has reached one of the
26 route key-points, a "default" branch is
27 displayed by the colour display unit
- 28 (ii) Once the navigation unit has determined
29 that the vehicle has reached a route key-
30 point on one of the branches, the current
31 route display function identifies the
32 branch corresponding to the reached route

1 key-point and the colour display unit
2 displays the path ahead to the next route
3 key-point on the branch
4 (iii) As the vehicle reaches further route key-
5 points, the current route display function
6 identifies its corresponding branch and
7 displays the path ahead to the next route
8 key-point on the branch.
9
10 If a number of branches emanate from the last route
11 key-point reached by the vehicle, a branch is
12 selected by the current route display function and
13 the next route key-point along the selected branch
14 is determined. The colour display unit then
15 displays the route ahead to the next route key-point
16 on the selected branch. If the vehicle passes this
17 route key-point, the current route display function
18 determines the next route key-point along the
19 present branch.
20
21 For example, consider the situation in which a
22 vehicle encounters a fork with two potential
23 branches Branch₁ and Branch₂. In this case the
24 current display function selects a branch, e.g.
25 Branch₁ and determines the next route key-point
26 along Branch₁, namely Key_point_{x,1}. The current
27 display unit then displays the route ahead for the
28 vehicle from its current position at the fork to
29 Key_point_{x,1}. If the navigation system determines
30 that the vehicle has passed Key_point_{x,1}, the current
31 display function determines the next route key-point
32 along the branch, namely Key_point_{x+1,1}.

1 However, if the initial route key-point on the
2 selected branch is not passed by the vehicle, it is
3 likely that the driver drove onto the branch which
4 was not selected and displayed by the current
5 display function. In this case, the current display
6 switches to the unselected branch and displays the
7 route ahead to the next route key-point on the newly
8 selected branch. Using the same example as before,
9 should the navigation unit determine that the
10 vehicle did not pass Key_point_{x,1}, the current display
11 function switches to Branch₂ and displays the route
12 from the fork to Key_point_{x,2}. If the vehicle passes
13 Key_point_{x,2} the current display function displays
14 the route ahead to the next route key-point on the
15 branch, namely Key_point_{x+1,2}.

17 (c) Junction Display Function

19 (i) Simple Junctions

20 If a driver is approaching a junction, the junction
21 display function displays the junction in a
22 geographically-indicative pictogram similar to a
23 road-sign. The pictograms essentially take the form
24 of the pictograms displayed by the monochrome
25 display unit (see Figures 5a and 5b)

26
27 If a vehicle passes a preparation point (e.g. 1 mile
28 in advance of a motorway junction), a pictogram
29 representing the junction is inset on a portion of
30 the currently displayed map and the navigation unit
31 issues an audible message, warning the driver of the
32 nearby junction. The pictogram includes information

1 identifying the road which the driver should take
2 from the junction and an indication of the current
3 distance to the junction.

4
5 If the vehicle passes a warning point or an
6 instruction point (e.g. 400 yards in advance of a
7 junction) or a confirmation point (between
8 compounded junctions) a full-screen pictogram of the
9 junction is displayed unless suppressed by the
10 driver and a further audible warning message is
11 issued to the driver.

12
13 The full-screen pictogram of the junction includes
14 information identifying the name and/or number of
15 the **exit road** to be taken from the junction,
16 together with an indication of the class of the
17 exit-road. The pictogram also includes information
18 identifying the name and/or number of the current
19 i.e. **entry road** together with an indication of its
20 class. The full-screen pictogram finally includes
21 an indication of the current distance to the
22 junction.

23
24 Once the vehicle has passed the junction, the full-
25 screen pictogram of the junction is removed from the
26 colour display unit and the current map is re-
27 displayed to the driver. Similarly if the driver
28 deviates from the route to the junction, the
29 junction pictogram is removed and the current map is
30 re-displayed to the driver.

31

32

(ii) Compound Junctions

The colour display unit is also capable of displaying compound junctions (in a similar way to the monochrome display unit).

If successive junctions along a prescribed route are located sufficiently close together it may not be possible to place the normal full complement of preparation points, warning points, instructions points between them and it may be necessary to use a restricted set of such route key-points to advise the driver of the required manoeuvre. For example, if a second turning is positioned within 600 yards of a first turning, it may not be possible to place a preparation point, warning point and instruction point between the turnings and the motorist will have to rely on the warning point and instruction point messages. As the distance between successive turnings decrease, the number of points available for providing messages to users also decrease. In extreme cases, there may not be enough space to place any preparation points, warning points, instruction points between successive junctions.

In the circumstance where junctions are located so close together that it is not possible to place any route key-points between the corresponding manoeuvre points, the junctions are shown in the full-screen pictogram as a compound series (as shown in Figure 8). The colour display unit can display a compound series comprising two junctions of any type or up to two roundabouts combined with one radial junction.

1 As a car approaches one of these compound junctions,
2 the colour display unit displays a full-screen
3 pictogram of the entire compound series. The full-
4 screen pictogram also displays text identifying the
5 name or number of the entry road to the first
6 junction and the name or number of the exit road
7 from the last junction of the compound series. A
8 compound instruction such as "turn right and then
9 immediately turn left" is issued at the instruction
10 point before the first manoeuvre.

11
12 As the car passes through the first junction of the
13 compound series and approaches each later junction,
14 the full-screen pictogram only displays the sub-
15 junction in question.

16
17 To ensure display of the next pictogram as soon as
18 possible after negotiating the first junction, the
19 display reverts to a map once the first candidate
20 route point has been reached after any compound
21 manoeuvre. A maximum of three junctions can be
22 compounded in this manner.

23

24 (iii) *Un-encoded Junctions*

25 Depending on the optimal route determined by the
26 central route advisory system, the driver may merely
27 be required to drive straight through a junction
28 (i.e. neither turn right nor left, nor turn around a
29 roundabout).

30

31 In these cases the navigation server neither encodes
32 speech nor pictograms for the junction and merely

1 places confirmation points around the junction to
2 detect whether the driver has turned on the junction
3 rather than going straight through it and as a
4 result has driven the car "off-route" (i.e. the
5 navigation server only places confirmation points
6 around the un-encoded junctions for off-route
7 detection). These unencoded junctions may be
8 recognised via their "CP-triplet" signature (as
9 previously described).

10

11 (d) Compass Aid Function

12

13 Should a driver lose his way from a pre-defined
14 optimal route, audible instructions to the driver
15 are often not very helpful for assisting the driver
16 to regain his route. Similarly, should the driver
17 change his mind as to his desired destination,
18 audible instructions are not very helpful for
19 enabling a driver to lock on to a new route.

20

21 In these circumstances, the compass aid function
22 provides an indicator in the form of an inset onto
23 the currently displayed map showing a dart pointing
24 to the nearest route key-point marker. On reaching
25 this marker, the optimal route to the desired
26 destination is re-calculated and displayed.

27

28 The processing algorithm for the Compass Aid
29 proceeds as follows:

30 1. While Guidance is active but the vehicle is not
31 on-route, on passing a route point the in-vehicle
32 device determines the "best" route key-point within

1 the current scanning window for (re)gaining the
2 prescribed route as follows;
3 2. If there are no candidate route key-points (i.e.
4 none within the speed-dependent matching radius)
5 then a successor of the nearest route key-point is
6 used (see 4 below);
7 3. If candidate route key-points are found (i.e.
8 within the speed-dependent matching radius) then a
9 successor of the candidate with the highest
10 "benefit" (i.e. considering both proximity and
11 alignment) is used;
12 4. In both cases 2,3, the "best" (to be pointed at)
13 is the first route key-point at least 30 yards from
14 the current vehicle position found by tracing
15 successors along the relevant "branch";
16 5. The in-vehicle device calculates the angle
17 between the current GPS heading and the azimuth of
18 the selected "best" route key-point, and sends this
19 angle to the display unit which responds by
20 displaying a dart graphic with 16 possible
21 orientations;
22
23 The compass aid function has two further modes of
24 operation, namely manual and automatic re-routing
25 modes.
26
27 In automatic re-routing mode, once the in-vehicle
28 device detects that the user has driven off a
29 prescribed route, the in-vehicle device initiates a
30 silent call to the central route advisory system (ie
31 without alerting the user). If during the call, the
32 in-vehicle device detects that the user has re-

1 gained the prescribed route, the silent call is
2 terminated without making the user aware of the
3 activities of the in-vehicle device. However, if
4 the in-vehicle device detects that the user has not
5 regained the prescribed route, it issues a beep to
6 warn the user and a new route is calculated based on
7 the current position of the vehicle.

8
9 In manual re-routing mode, if the in-vehicle device
10 detects that the user has driven off the prescribed
11 route, it will issue an audible warning to the user,
12 for example, "no longer on route, please do a U-turn
13 where safe". However, if the user is unable to
14 safely perform the U-turn, the user may manually
15 initiate a re-route request call to the central
16 route advisory system.

17
18 (e) Exit Indicator Function

19
20 Exit indicators provide an enhanced visual
21 indication of the exit direction from roundabouts
22 and radial un-encoded junctions.

23
24 The exit indicators dynamically change according to
25 the movements of the vehicle at the relevant
26 junction. In the case of a roundabout, the exit
27 indicator moves around the circular pictogram
28 (representing the roundabout) as the vehicle itself
29 moves around the roundabout. In the case of a
30 radial junction, the exit indicator is adjusted as
31 the vehicle approaches the junction.

32

1 (f) Safety Camera Warning Function

2

3 The navigation unit uses this function to generate
4 audible warnings to the driver of nearby road-side
5 speed cameras. In addition, the colour display unit
6 displays an icon depicting the camera and an
7 indication of the speed limit relevant to the
8 camera.

9 3. TELEPHONE FUNCTIONS

10

11 Calls to the call centre are not regarded as "user"
12 voice calls because the in-vehicle navigation unit
13 always follows up such calls with a data call to the
14 central route advisory system.

15

16 The colour display unit provides a user interface to
17 enable a driver to use the in-vehicle mobile
18 telephone device to make and receive conventional
19 voice-calls. The in-vehicle mobile telephone device
20 can also be used to receive text messages which can
21 be displayed on the colour display unit. These
22 facilities are made possible by the telephone
23 functions of the colour display unit.

24

25 The telephone functions can be broadly divided into
26 functions for making and receiving voice calls and
27 functions for receiving and displaying text
28 messages. These functions will be described in more
29 detail below.

30

31

32

(a) Voice Calls

1
2
3 The telephone: voice calls function enables a user
4 to use the touch screen of the colour display unit
5 as a telephone keypad similar to the keypad of a
6 conventional mobile phone. The colour display unit
7 telephone keypad may then be used as a user-
8 interface to the in-vehicle mobile telephone device
9 to enable the driver to make a voice call to a
10 desired telephone number.

11
12 On activating the telephone option the user is
13 provided with the following functions:

14 (a) **Keypad**

15 Converts the colour display unit touch screen
16 into a telephone key-pad. As a number is
17 entered by the driver, the number is displayed
18 on the colour display unit.

19 (b) **Store and Recall**

20 The mobile telephone device in the in-vehicle
21 device includes a memory for storing up to ten
22 frequently used telephone numbers. Each of
23 these numbers has an associated single digit
24 identifier. The store function enables a user
25 to store a number in the mobile telephone
26 device memory in which case the stored number
27 is automatically allocated a number which acts
28 as its identifier. The user can display a
29 stored number using the recall function
30 together with the single digit identifier. The
31 recalled number can then be dialled using the
32 call function.

1 (c) **Recall**

2 (d) **Call**

3 Submits the number entered by the driver to the
4 mobile telephone device for dialling. If the
5 recipient telephone system is engaged, the call
6 function is switched to a redial mode, until
7 the user exits the telephone function menu.

8 Alternatively, if the call is connected to the
9 recipient, the "store" and "recall" functions
10 are suppressed.

11 (e) **Delete**

12 Removes individual digits from an entry or the
13 entire entry itself.

14

15 The above functions enable a driver to make a call
16 from the in-vehicle device. However, the in-vehicle
17 device may also be used to receive calls from
18 external sources. In this case, the colour display
19 unit displays the telephone number of the incoming
20 call and the driver is provided with the option to
21 accept or reject the call.

22

23 Suppression of Spoken Instructions

24 During a voice call or the ringing of the in-vehicle
25 device's mobile phone (on receipt of an incoming
26 telephone call) the in-vehicle device cannot play
27 audible instructions to the driver because the in-
28 vehicle device's audio output is being used for the
29 voice call. In circumstances such as this, the
30 normal instruction playback functions of the in-
31 vehicle device are suppressed in favour of the
32 ongoing voice call. When it is necessary for the

1. navigation unit to provide guidance instructions
2. etc. to the driver, the navigation unit generates a
3. discreet alert tone, whereupon the driver can use a
4. repeat function to interrupt the voice call (without
5. disconnecting the caller). In this case, the
6. navigation unit temporarily takes over control of
7. the audio system of the in-vehicle device to repeat
8. the instruction to the driver. When the instruction
9. message is completed, the navigation unit releases
10. control of the audio system to the audio system.

11

12. Should the driver not wish to interrupt the current
13. voice-call with the guidance instruction from the
14. navigation unit, the driver may continue with the
15. voice call and once the call has ended, use the
16. repeat function to repeat the last instruction.

17

18. SOS Facility

19. The in-vehicle device software includes an optional
20. facility to enable a user to call for assistance in
21. cases of emergency and breakdown and to transmit an
22. SMS message indicating the location of the caller to
23. the operator of the emergency service. On
24. initiating the SOS call, any active calls to the in-
25. vehicle device (user voice calls, calls to the
26. central route advisory system or route uploads) are
27. terminated immediately.

28

29. (b) Text Messaging

30

31. The in-vehicle can also display text-based
32. information of the following categories:

1 (a) Incident

2 (b) Text Messages

3

4 **(a) Incident Information**

5 Text based "incident" messages may be transmitted to
6 a driver as a supplement to the icon based display
7 of traffic delays. These "incident" messages convey
8 specific incident information, e.g. relating to
9 accidents or road closures. The information is
10 encoded to relate to specific geographical areas
11 within the country and the user will only be alerted
12 to the incident if it is relevant to the currently
13 displayed map area.

14

15 **(b) Text Messages**

16 As discussed above, the in-vehicle device may
17 display received SMS messages. SMS messages from
18 certain designated sources are used solely by the
19 navigation unit and are not displayed to the user.
20 Messages from any other sources are deemed
21 "personal" and displayed to the user. Up to 10 SMS
22 messages may be stored in a non-volatile memory
23 associated with the in-vehicle device mobile
24 telephone.

25

26 Both the textual content of any stored SMS messages
27 and the CLI (phone number) of the caller can be
28 displayed together with an icon indicating whether
29 the message has been read or not.

30

31

32

B. GUIDANCE ACTIVE MODE

1
2
3 In guidance active mode, the navigation device
4 actively advises the user of the optimal route to a
5 required destination. The touch-screen of the
6 colour display unit thus acts as a user interface to
7 the in-vehicle navigation unit enabling the user to
8 make a manual voice call to the central route
9 advisory system before commencing a journey
10 requesting routing advice to the desired
11 destination.

12
13 Furthermore, the user can use the touch screen of
14 the colour display unit to request a new route to
15 the destination even if the vehicle is progressing
16 along a previously downloaded optimal route to the
17 destination. In this case the navigation unit
18 cancels the old route and continues with the new
19 route.

20
21 In addition, if the driver has deviated from the
22 previously prescribed route, the driver can request
23 the route guidance system to prepare a new route to
24 the required destination, using the re-route
25 function.

26
27 Finally, the driver can reversibly mute audible
28 guidance or traffic-related instructions. In this
29 case the in-vehicle navigation unit continues
30 scanning and matching route key-points but
31 suppresses off-route re-route processing and the
32 display of junction pictograms.

C. INACTIVE GUIDANCE MODE

1
2
3 In the guidance inactive screen mode the user can
4 obtain guidance instructions to a particular
5 destination with making a manual call to the central
6 route advisory system. In this case, route requests
7 are made automatically by the in-vehicle device in
8 accordance with the request of the user.

9
10 In particular a driver may request a route to a
11 destination selected from a set of saved favourite
12 destinations. In this case the selected destination
13 is transmitted to the navigation server (without
14 requiring human operator intervention) and after
15 validating the destination, the server automatically
16 transmits the route to the in-vehicle navigation
17 unit.

18
19 Similarly, the user may request a route to a
20 previously visited destination. In use a navigation
21 unit of an in-vehicle device stores in an on-board
22 memory, the latitude and longitudes of the most
23 recent previously requested destination. When the
24 driver selects the previous destination option, the
25 latitude and longitude of the destination are
26 automatically transmitted to the navigation server
27 which transmits an appropriate route to the in-
28 vehicle device navigation unit.

29
30 It will be understood that since the vehicle's
31 location may have changed since the request was made
32 for a route to the previous destination and the

1 prevailing traffic conditions may have also changed,
2 that the route transmitted by the navigation system
3 server may differ from the route previously
4 suggested to the destination.

5
6 Finally, the driver may identify a destination
7 according to its post-code. In this case the post-
8 code is automatically transmitted to the navigation
9 server (without requiring human operator
10 intervention) and the route is automatically
11 transmitted back to the driver's navigation unit.

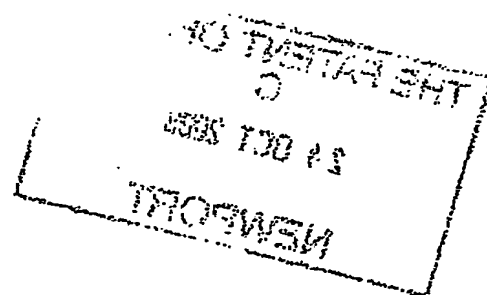
12 D. HELP MODE

13
14
15 When the colour display unit is operating in help
16 mode, the user can customise the sounds produced by
17 the in-vehicle device. For example, the user can
18 enable or disable the sounding of a warning tone
19 when a text message is received by the in-vehicle
20 device and can also change the volume of audible
21 warning messages

22
23 Similarly, the user can customise the guidance menus
24 displayed by the colour display unit, so for
25 example, the colour display unit may be directed to
26 display pictographic representations of junctions
27 only and suppress the display of map information.
28 Furthermore, the user can also customise screen and
29 display attributes.

30

- 1 This invention is not limited to the embodiments
- 2 herein described which can be varied in construction
- 3 and detail.



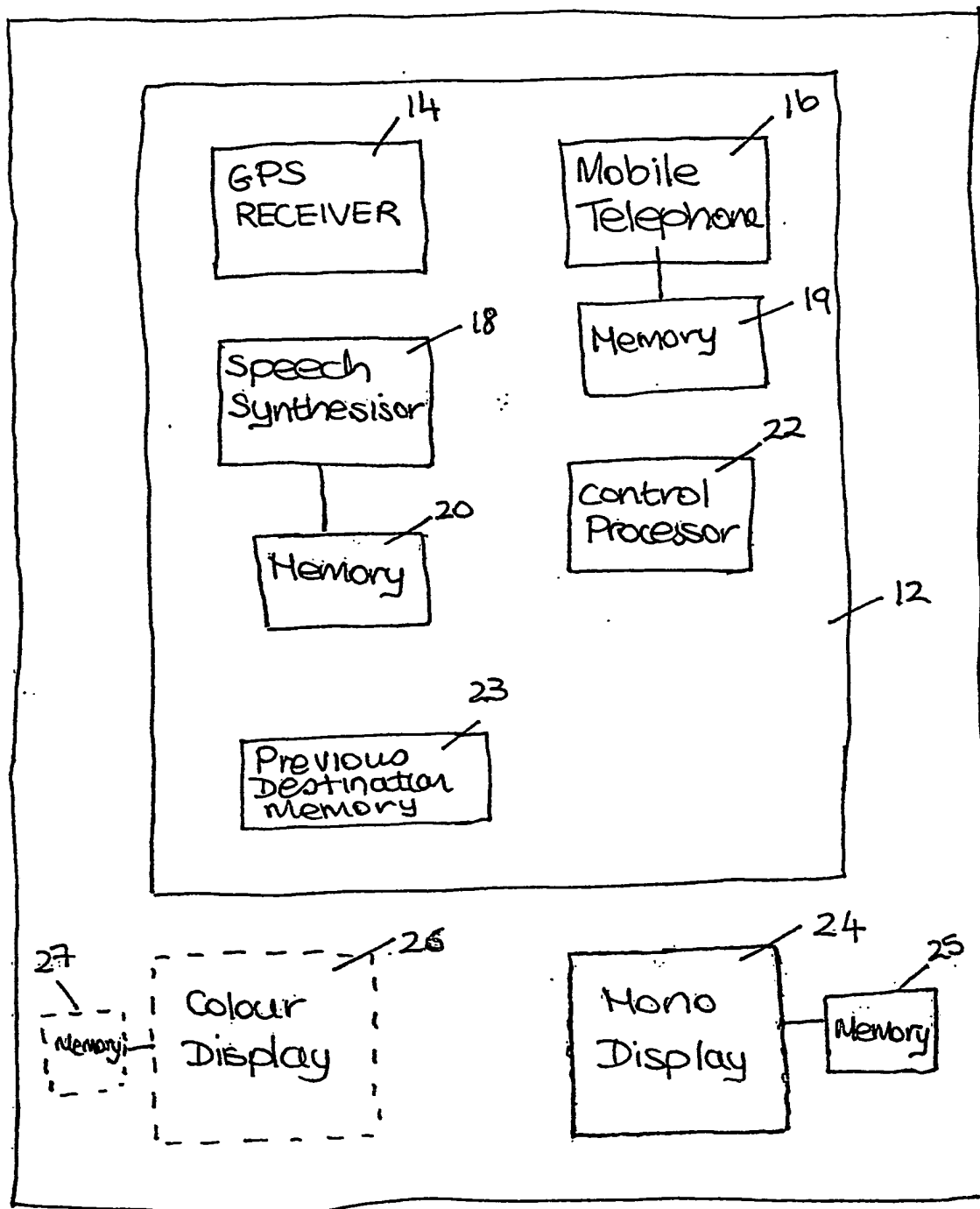


Fig. 1

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30

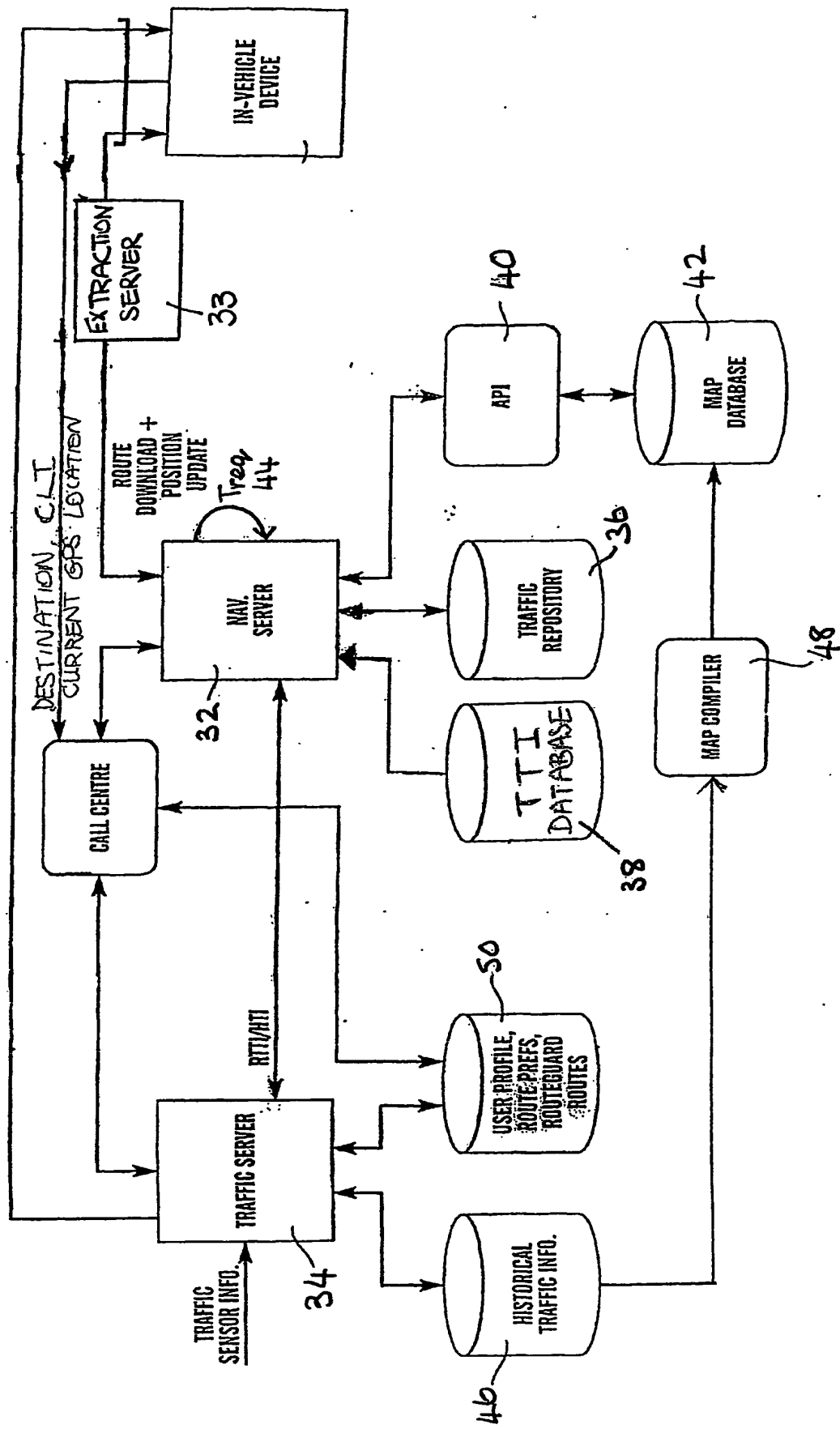


Fig. 2

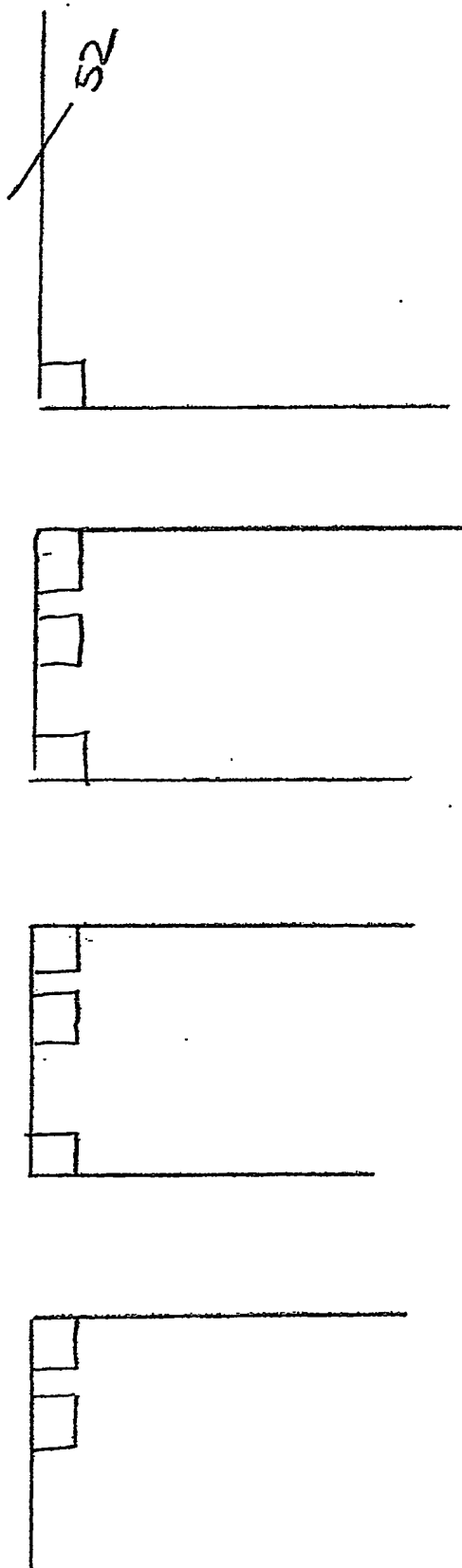
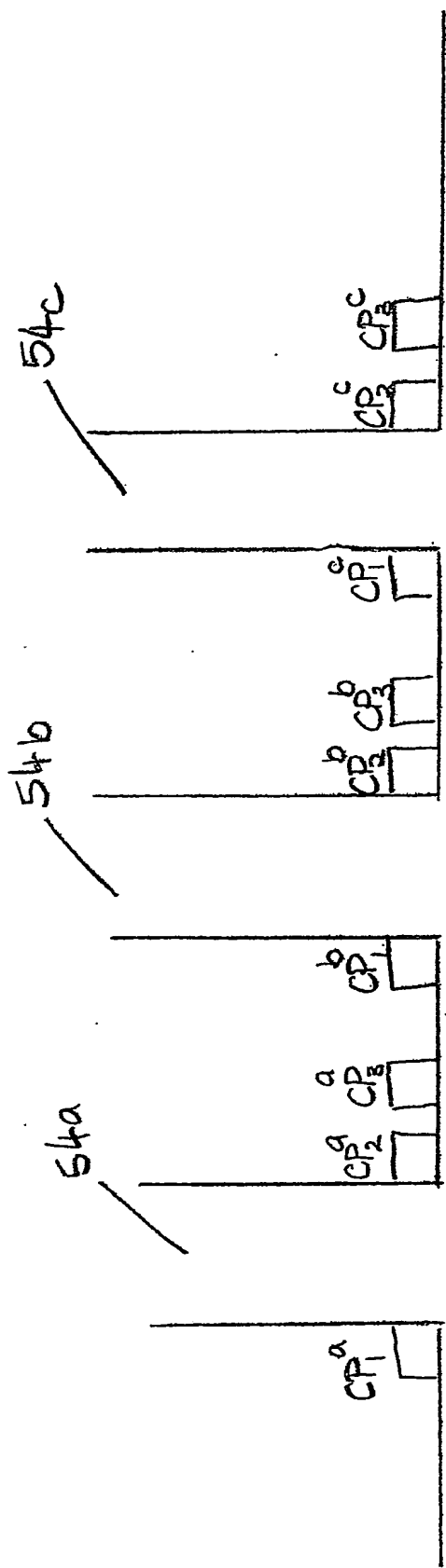


Figure 3

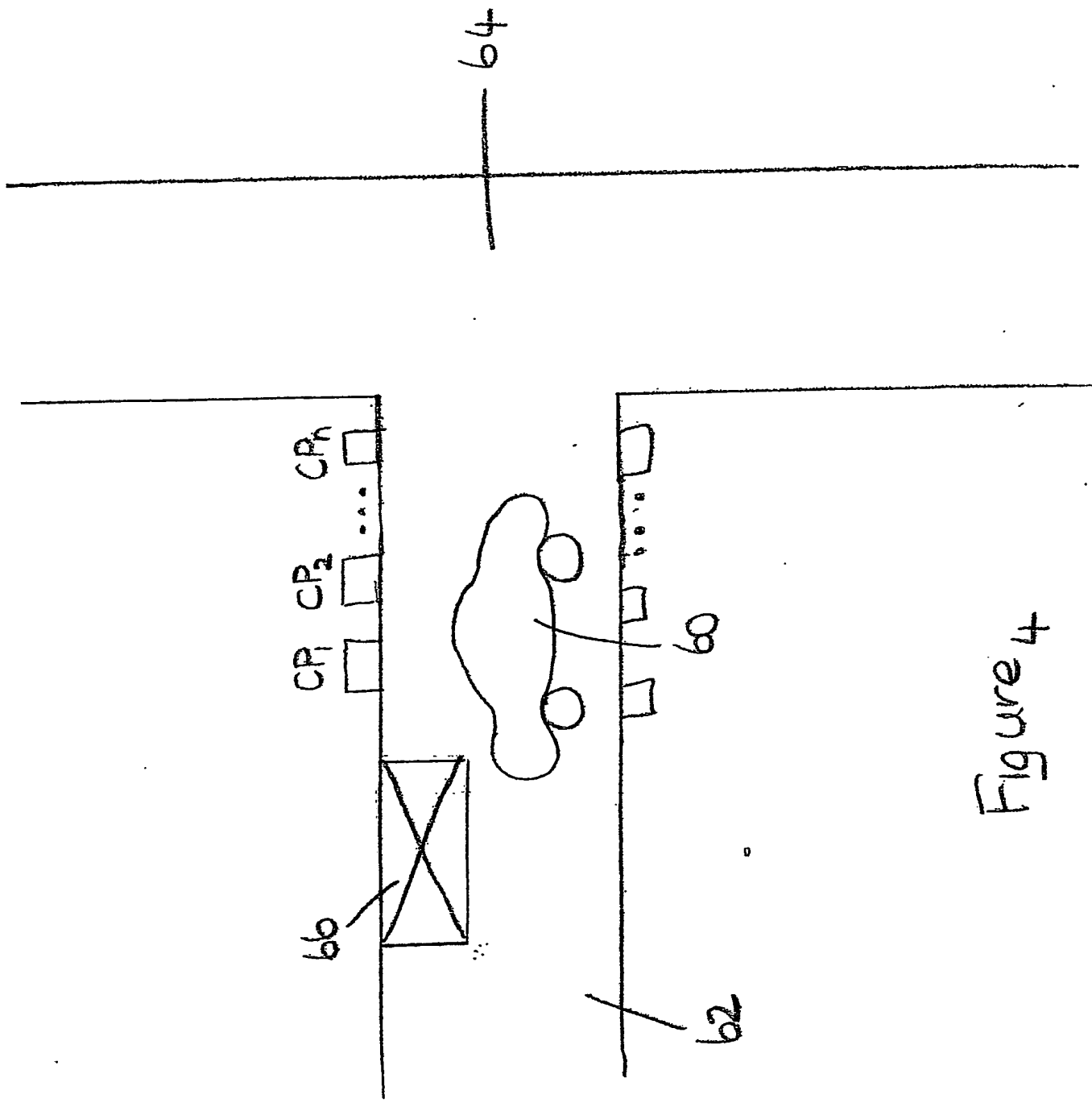


Figure 4

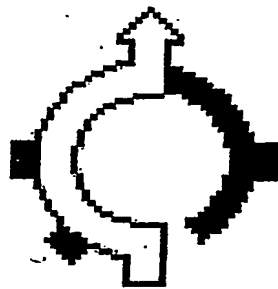


Fig. 5A

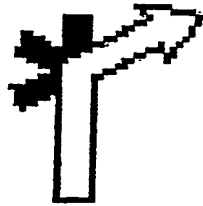


Fig. 5B

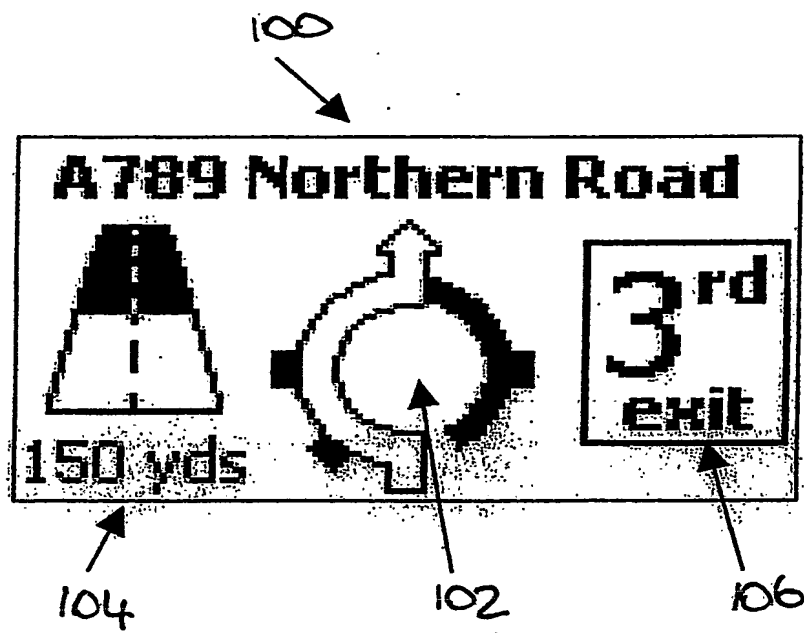


Fig. 6

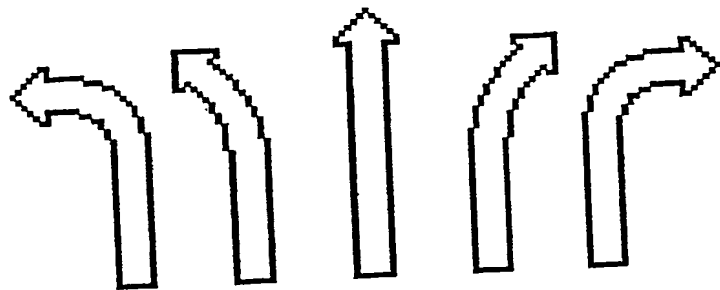


Fig. 7

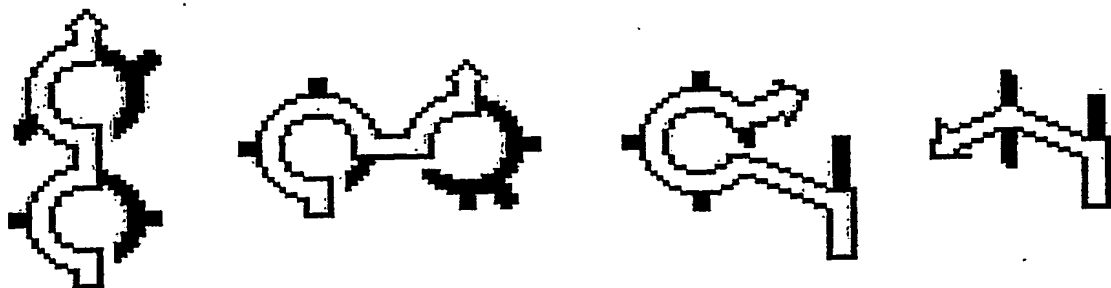


Fig. 8

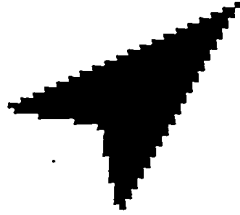
High Street**350**
yards**ETA:**
09:50**Dist:**
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Fig. 9

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